

Malignant Humeral Bone Tumors in Children: Excision and Reconstruction With the Use of Rotated Clavicle

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The application of intensive multimodality therapy has made possible salvage surgery in bone tumors. Reconstruction of the removed part of bone is the great problem, especially in fast-growing children. In three patients (two osteosarcomas and one Ewing's sarcoma), the tumor was confined to the proximal half part of humerus, without invasion of shoulder joint. After induction chemotherapy, reduction of tumor size was observed both clinically and radiologically. During the operation, wide resection of the tumor together with a 12- to 14-cm-long fragment of humerus, was performed. Afterward, the clavicle was rotated in the place of the removed bone, with preservation of the coracoacromial ligament. The humeral stump and clavicle were fixed with the use of metal plate. Adjuvant chemotherapy was used a few days following surgery. After 3 months, the osteosynthesis had healed. The movements in shoulder joint are limited, but functions of elbow joint remained normal. All children are alive and disease free. Reconstruction of humerus with clavicle rotation is possible when the proximal bone loss is not longer than 10-14 cm. This method seems to be an alternative to allogeneic grafts and endoprostheses.

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INTRODUCTION

During the last decade, the treatment of childhood malignancies has changed radically. The introduction of intensive chemotherapy as part of a multimodality treatment had a substantial influence on the treatment strategy in this group of patients.

The use of neoadjuvant chemotherapy causes the regression of the tumor, which makes possible less mutilating operations, although radical by histopathological assessment. Chemotherapy and/or radiotherapy are given after surgery in order to protect against potential metastases.

The progress achieved with the application of a comprehensive treatment had a significant impact on the role of oncological surgery with regard to salvage operations [1-4].

Less mutilating amputations, tumor excisions with small, partial bone resections, tumor resections with wide tissue excisions began to be performed. The next step was to elaborate new reconstructive techniques enabling the replacement of extensive bone and soft tissue losses with the use of oncological endoprostheses, bone grafts and muscle flaps. This mode of surgery reconstructs cosmetic and functional deficits. Such problems are difficult to resolve, especially with regard to young children during the period of fast growth.

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Fig. 1. Patient with osteosarcoma before operation.

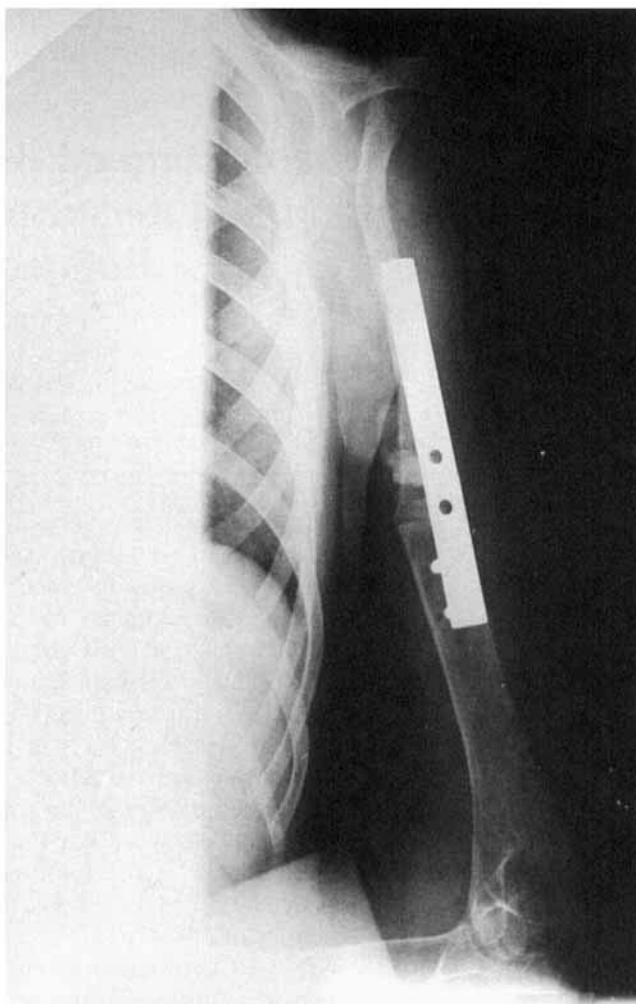


Fig. 2. Same patient as in Figure 1 at 6 weeks after operation.

MATERIAL AND METHODS

Three patients whose tumor with one half of proximal humerus was excised are presented. The rotated clavicle was used to reconstruct the bone deficit.

The first of the described patients was a 13-year-old girl with osteogenic sarcoma, the second was a 13-year-old boy with osteogenic sarcoma, and the third was a 12-year-old boy with Ewing's sarcoma. Tumors were located in one-half of the proximal part of the humerus without infiltration of the shoulder muscles by the tumor. After radiologic examination (plain bone films, computed tomography [CT], scintigraphy), stage IIA (1) and IIB (2) by Enneking was established. Induction chemotherapy resulted in a significant reduction of tumor mass and it was decided to perform a salvage operation.

During surgery, after isolation of vessels the wide resection of tumor (by Enneking) together with 12–14 cm of proximal humerus was done. Radical excision was

confirmed intraoperatively by histopathological assessment of soft tissues, the site of bone division, and bone marrow. Following transection of both sternoclavicular and costoclavicular ligaments, the clavicle was isolated from surrounding tissues. The coracoclavicular ligament was also divided. Only the acromioclavicular joint with its ligaments was preserved. The clavicle was displaced downwards in order to reconstruct the bone deficit. After removal of the cartilaginous part of the clavicle, the bones were joined with the use of a metal plate and 4 screws. The preserved parts of the biceps and triceps were used to cover the bone.

After operation, the upper limb was immobilized in a Desault dressing. Chemotherapy was resumed after wound healing and continued for 6 months. Complete bone healing was achieved 3–5 months following surgery. In the first patient a fracture due to overstraining and trauma had to be reoperated. The adhesion healed after 4 months. The children are alive and disease free at 3

years, 10 months, and 1 year 10 months, respectively. In the patient with Ewing's sarcoma, radiotherapy was not given during the postoperative period.

Rehabilitation is the most important part of postoperative treatment. The success of reconstruction of the humeral deficit with the use of rotated clavicle is related to muscle loss, which depends on the extent of the tumor at operation. This fact has the greatest impact on the mode of rehabilitation (kinesiotherapy) of the patient. Limitations of movement, flexion and abduction are encountered most frequently in the shoulder. The advantage of this operation depends on the preservation of full-range movements of elbow and hand. After removal of the plaster of Paris, passive and active exercises with lightening of the shoulder are performed. Gradual increase in the flexion and abduction range is instituted. The elbow joint has to be exercised in order to strengthen the joint extensors and to soften the flexion contracture. It is important to strengthen the muscles responsible for retraction of the shoulder girdle, which corrects the morphological loss of the clavicle. After 2–3 weeks, active free movements of the shoulder can be initiated. Exercises against resistance should be avoided.

DISCUSSION

The achievements in the treatment of malignant bone tumors gave new opportunities to surgical oncology. The effectiveness of multimodality therapy showed that mutilating surgery is not necessary in all instances. Wide tumor resection turned out to be as effective as mutilating surgery in terms of survival. However, several problems

related to dynamic bone growth in children remained unresolved.

In some patients local excision of the tumor together with the proximal humeral epiphysis can be done. Many reconstructive techniques with the use of endoprotheses, bone grafts, and Kuntscher's nails were used in an effort to preserve the function of the upper extremity [1–4]. One of the technical possibilities is using the rotated clavicle to substitute the bone deficit. This kind of surgery, applied first in adult patients, was presented by Dr. Winkelmann at the European Musculoskeletal Oncology Society meeting (EMSOS) in Birmingham [5].

In our opinion, this method is especially useful in children. It allows the full function of hand and forearm and allows the possibility of further limb growth. It permits reconstruction of bone loss of 10- to 14-cm length. This method should be considered as an alternative to allogeneic grafts and endoprotheses.

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